

Application No.: 10/678,766
Filing Date: October 2, 2003

REMARKS

Claims 1, 3-24 and 26-35 are pending in the present application. New Claims 36-39 have been added. Support for the new claims can be found in the specification and claims as filed, for example in original Claim 1 and at paragraph [0048] and Example 2 of the application as published.

Claims 1, 3-9, 11-24 and 26-35 stand rejected as obvious over George et al. ("Surface Chemistry for Atomic Layer Growth") in view of Sandhu et al. (U.S. Patent No. 6,313,035), Suntola ("Atomic Layer Epitaxy"; 4.2.3 Heterostructures of III-V Compounds, pp. 296-297) and Suntola et al. (U.S. Patent Nos. 6,015,590). Claim 10 has been rejected as unpatentable over George et al., in view of Sandhu et al., Suntola and Suntola et al. as applied to the claims above, and further in view of Lowrey et al. (U.S. Patent No. 5,891,744). These rejections are traversed.

A Reason to Combine the References Has Not Been Established

In the Supreme Court's recent decision in *KSR International Co. v. Teleflex Inc.*, 550 U.S. ____ (2007), the Court repeatedly emphasized the value of determining if there is any "reason to combine" the various teachings in the art. The Court noted that "[a] patent composed of several elements is not proved obvious merely by demonstrating that each element was, independently, known in the prior art." (*KSR*, Syllabus, page 4 and page 14).¹ Thus, the Court has made it abundantly clear that some reason to combine the various elements must be present in order to establish a *prima facie* case of obviousness.

The Examiner states on pages 2-3 of the Office Action that George et al. discloses ALD growth of oxides and the "technical means to alternate between various materials with atomic layer control and form superlattices" but concedes that George et al. does not disclose a thin film comprising *silicon and a metal*. Thus, George has no teaching of a metal silicon oxide or how to make a metal silicon oxide by ALD. The Examiner refers to Sandhu et al. for disclosing a multi-component oxide layer that comprises a "mixture" of metal oxide and silicon oxide formed by

¹ The Court also noted that "it can be important to identify a reason that would have prompted a person of ordinary skill in the art to combine the elements as the new invention does." (*KSR*, Syllabus, page 5; see also, page 15). Additionally, the Court noted that "inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." (*KSR*, page 15).

Application No.: 10/678,766
Filing Date: October 2, 2003

CVD and concludes that it would have been obvious to a person of ordinary skill in the art to modify George by selecting silicon dioxide and a metal oxide because it can form a useful multicomponent oxide layer which can be used to manufacture a useful semiconductor device, as disclosed by Sandhu.

Applicants disagree. There is simply no reason provided by Sandhu (or George) to use ALD to form a metal silicon oxide. Further, there is no teaching in either George or Sandhu that ALD of silicon dioxide and a metal oxide can be used to form a metal silicon oxide, much less any teaching of how one would go about forming a metal silicon oxide by ALD. Thus, there is no reason for one of skill in the art to modify the methods of George to deposit a metal silicon oxide or any teaching of how one would do so.

The Examiner further concedes that the combination of George et al. and Sandhu et al. “does not teach a plurality of consecutive deposition cycles that each deposit only a MSiO_x,” but alleges that these steps are disclosed by Suntola (4.2.3 Heterostructures). The section of Suntola referred to by the Examiner teaches ALD methods for forming superalloys and superlattices of *Group III-V compounds*. There is no teaching or suggestion in the portion of Suntola cited by the Examiner relating to the deposition of metal oxides, silicon oxides, or metal silicon oxides. As a result, one of skill in the art would have no reason to look to the cited teachings of Suntola to modify the methods of George. The cited teachings of Suntola are simply not relevant.

In view of the lack of teaching in George of any multicomponent oxides, the lack of a reason to deposit metal silicon oxide by ALD and the lack of relevance of the cited teachings of Suntola, Applicants respectfully submit that a *prima facie* case of obviousness has not been established and request withdrawal of the rejection.

Unexpected Results

Secondary considerations must be considered in every case where they are presented. *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538 (Fed. Cir. 1983); *KSR International Co. v. Teleflex Inc.*, 550 U.S. ____ (2007). These include factors such as unexpected results. *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1380 (Fed. Cir. 1986); *Graham v. John Deere*, 383 U.S. 1 (1966); *In re Sullivan*, No. 2006-1507 (Fed. Cir. 2007) (holding the PTO is obligated to consider applicant evidence of secondary consideration in cases where

Application No.: 10/678,766
Filing Date: October 2, 2003

obviousness is at issue). Unexpected results can rebut a *prima facie* case of obviousness because that which would have been surprising to a person of ordinary skill in a particular art would not have been obvious. *In re Soni*, 54 F.3d 746 (Fed. Cir. 1995).

Again, Applicants disagree that the Examiner has established a *prima facie* case of obviousness. However, even assuming *arguendo* that a *prima facie* case of obviousness has been established, Applicants submit that the unexpected results of the claimed methods discussed below necessitate a finding of nonobviousness.

The inventors of the present application have discovered unexpectedly that the growth rate of metal silicon oxides is faster than the growth rates of the corresponding metal oxide or silicon oxide. (See p. 3 of the Application). That is, the growth rate of the metal silicon oxides is higher than that of either individual oxide from which the metal silicon oxide is formed. This is illustrated in the table below:

Oxide	Growth Rate Å/c	Metal Silicon Oxide	Growth Rate Å/c
TiO ₂ from TiCl ₄	0.5	SiTiO _x	0.9
Ta ₂ O ₅ from TaCl ₅	0.43	SiTaO _x	1.1
HfO ₂ from HfCl ₄	0.5	SiHfO _x	1.23
ZrO ₂ from ZrCl ₄	0.5	SiZrO _x	1.1
La ₂ O ₃ from La(thd) ₃	0.36	SiLaO _x	0.75
Y ₂ O ₃ from Y(thd) ₃	0.23	SiYO _x	0.73
SiO ₂ from AMTMS	0.2		

As can be seen in the table, the growth rates of TiO₂, Ta₂O₅, HfO₂, ZrO₂, La₂O₃, Y₂O₃ and SiO₂ by ALD have been shown to be 0.5 Å/cycle (Å/c), 0.43, 0.5, 0.5, 0.36, 0.23 and 0.2, respectively. See Leskela et al. (J. de Phys. IV, 5:937-951 (1995)), Nieminen et al. (Appl. Surf. Sci. 6915:1-12 2001)), Ritala et al. (Thin solid Films 225:288-295 (1993)), Ritala et al. (Appl. Surf. Sci. 75:333-340 (1994)) and Putkonen et al. (Chem. Vap. Dep. 7:44-50 (2001)), submitted with the IDS accompanying this paper, and paragraph [0048] of the specification as published. Surprisingly, as disclosed in the present Application, the Applicants found the growth rate of the corresponding metal silicon oxides, as deposited by ALD using the same precursors (see Example 2 of the specification), to be significantly higher than either the metal oxide or silicon oxide individually. As discussed in more detail below, the data are provided in terms of growth rate per cycle, where a cycle comprises the provision of metal or silicon precursor (see

Application No.: 10/678,766
Filing Date: October 2, 2003

paragraphs [0062] and [0063]). Thus, the growth rate of the metal silicon oxide is determined by dividing the thickness by the total number of metal cycles *and* silicon cycles.

As illustrated in the table above, the growth rate of SiTiO_x was found to be 0.9, compared to a growth rate of 0.5 for TiO_x and 0.2 for SiO_2 . For SiTaO_x a growth rate of 1.1 was observed, compared to a growth rate of 0.43 for Ta_2O_5 and 0.2 for SiO_2 . For SiHfO_x a growth rate of 1.23 was observed, compared to 0.5 for HfO_2 and 0.2 for SiO_2 . For SiZrO_x a growth rate of 1.1 was observed compared to a growth rate of 0.5 for ZrO_2 and 0.2 for SiO_2 . For SiLaO_x a growth rate of 0.75 was observed compared to a growth rate of 0.36 for La_2O_3 and 0.2 for SiO_2 . Finally, for SiYO_x a growth rate of 0.73 was observed, compared to a growth rate of 0.23 for Y_2O_3 . (See Example 2 of the Application). Thus, again, the inventors have found the growth rate of the silicon metal oxide to be significantly greater than, and often more than double the growth rate of the corresponding metal oxide and silicon oxide.

Applicants note that the Examiner previously found the Applicants' argument of non-obviousness due to unexpected results unpersuasive, as set forth on pp. 10-11 in the Office Action mailed December 28, 2006. In particular, the Examiner stated that the higher growth rate of a multicomponent oxide is "expected" over the growth rate of a single-component oxide because a cycle of a multicomponent oxide deposition includes twice as many deposition steps, or in other words that a silicon oxide and a metal oxide are formed in "one cycle" for the multicomponent oxide, whereas only silicon oxide or metal oxide is formed in one cycle for a single-component oxide. Applicants respectfully submit that this is an incorrect reading of the data presented and that this distinction has been taken into account in the comparison provided above and in the specification. The actual comparison being made is per deposition cycle for each of the oxides that make up the multicomponent oxide. The Application is clear that in comparing the growth rate of a multicomponent oxide to individual metal oxide and silicon oxide growth rates, a cycle is expressed in terms of a single cycle of metal oxide or a single cycle of silicon oxide. See paragraph [0048] and Example 2 of the Application. For example, the Application states that a threefold increase in growth rate for SiYO_2 and SiLaO_2 is achieved with a "cycle ratio of 1:1," or when a cycle of metal oxide is alternated with a cycle of silicon oxide. Evaluating the growth rates of a multicomponent oxide, silicon oxide and metal oxide in a way that fails to standardize the units of comparison, would be uninformative and unreasonable and is

Application No.: 10/678,766
Filing Date: October 2, 2003

not, in fact, the comparison that is being made by Applicants. Applicants note that a comparison of the growth rate of the complete metal oxide to the sum of the growth rates of metal oxide and silicon oxide, as the Examiner originally and incorrectly interpreted the results, would reflect the unexpected increase in growth rate of the metal silicon oxide, although these data are not presented. Accordingly, Applicants respectfully request reconsideration of the actual unexpected results as clearly set forth throughout the Application.

Furthermore, the Examiner previously suggested that the claims were not commensurate in scope with the unexpected results. Applicants previously pointed the Examiner to the unexpected results for SiLaO_x and SiYO_x. However, as noted above, the unexpected results have been observed for metal silicon oxides prepared with six different metals. Applicants respectfully submit that in view of the presentation of unexpected results for six different metals, one of skill in the art would appreciate that the advantages of the claimed methods extend to all metals. Thus, the claims are commensurate in scope with the unexpected results.

Applicants submit that the clear showing of unexpected results overcomes any *prima facie* case of obviousness. Accordingly, Applicants request that the obviousness rejections be withdrawn.

No Disclaimers or Disavowals

Although the present communication may include alterations to the application or claims, or characterizations of claim scope or referenced art, the Applicants are not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. The Applicants reserve the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that the Applicants have made any disclaimers or disavowals of any subject matter supported by the present application.

Application No.: 10/678,766
Filing Date: October 2, 2003

Conclusion

Applicants respectfully submit that the present application is in condition for allowance and respectfully request the same. If any issues remain, the Examiner is cordially invited to contact Applicants' representative at the number provided below in order to resolve such issues promptly.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: October 31, 2007

By:



Andrew N. Merickel
Registration No. 53,317
Attorney of Record
Customer No. 20995
(415) 954-4114

4481445
103107